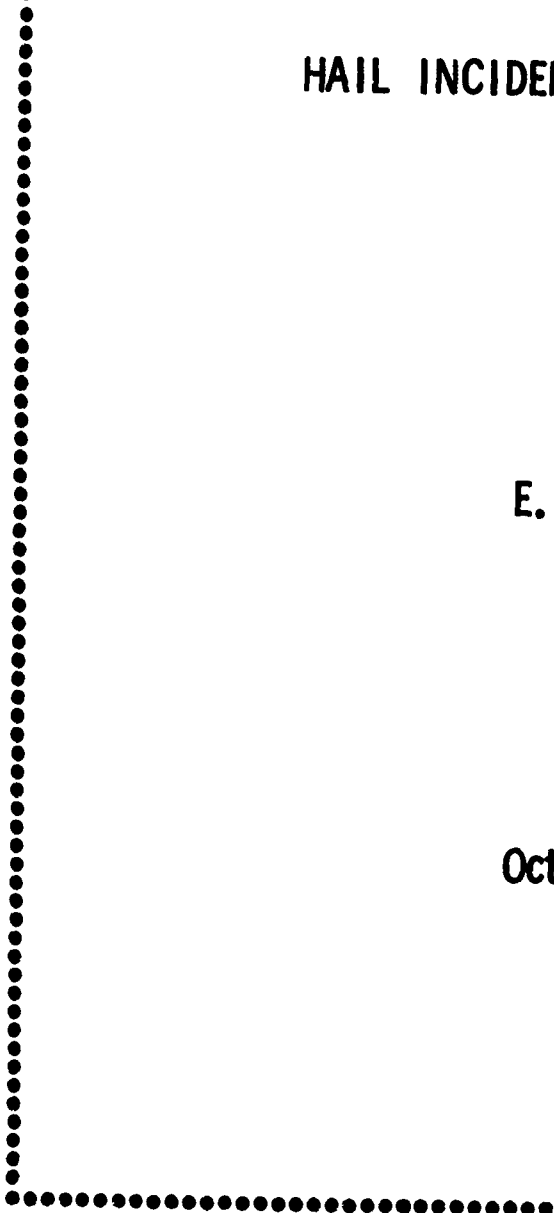


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Technical Report ECOM-2768

**HAIL INCIDENCE IN THE TROPICS**

by

E. M. Frisby

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**Technical Report ECOM-2768**

**HAIL INCIDENCE IN THE TROPICS  
PART II**

**by**

**E. M. Frisby**

**Atmospheric Physics Division  
Atmospheric Sciences Laboratory**

**October 1966**

**DA Task No. 1V0-14501-B-53A-09**

**U. S. ARMY ELECTRONICS COMMAND  
FORT MONMOUTH, NEW JERSEY**

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## HAIL INCIDENCE IN THE TROPICS PART II

### INTRODUCTION

Two studies have been made utilizing the data included in the four appendices to the original report of the same name. \* The first study relates hailstorm frequency and station altitude; the second discusses hail regimes within the tropics.

### DISCUSSION

#### Study Number 1

In temperate latitudes, hailstorm frequency has been observed to increase with altitude. The data presented in the appendices to the first report demonstrate a similar correlation at low latitudes, despite variations in the length of individual records and the inclusion of a number of "exceptions to the rule."

Monthly haildays, listed on pages 24 to 45 of Technical Report ECOM 02105-F, were summed and averaged to give an annual average number of hailstorms for each station. Annual averages were then plotted against station elevation (Fig. 1).

By courtesy of the Geography Branch, U. S. Army Natick Laboratories, who supplied many station elevations after the first report had gone to press, more data are shown in Fig. 1 than appear in the appendices to the original report.

The majority of stations in the tabulation are below 1200 meters and experience fewer than two haildays, on average, per year. The remainder, above 1200 meters, show a tendency to experience an average of three to eight haildays per year, or even more.

#### Study Number 2

Initially, hailstorm distribution graphs were drawn monthly for observation stations considered to be representative of the countries from which hail data were received (Figs. 2, 3, and 4). Next, composites of hail incidence were prepared for areas that appeared to experience about the same hail season.

\*Technical Report ECOM-02105-F, "Hail Incidence in the Tropics," dated September 1966, prepared by Raven Industries, Inc., for the Atmospheric Sciences Laboratory, under Contract DA28-043 AMC-02105(E).

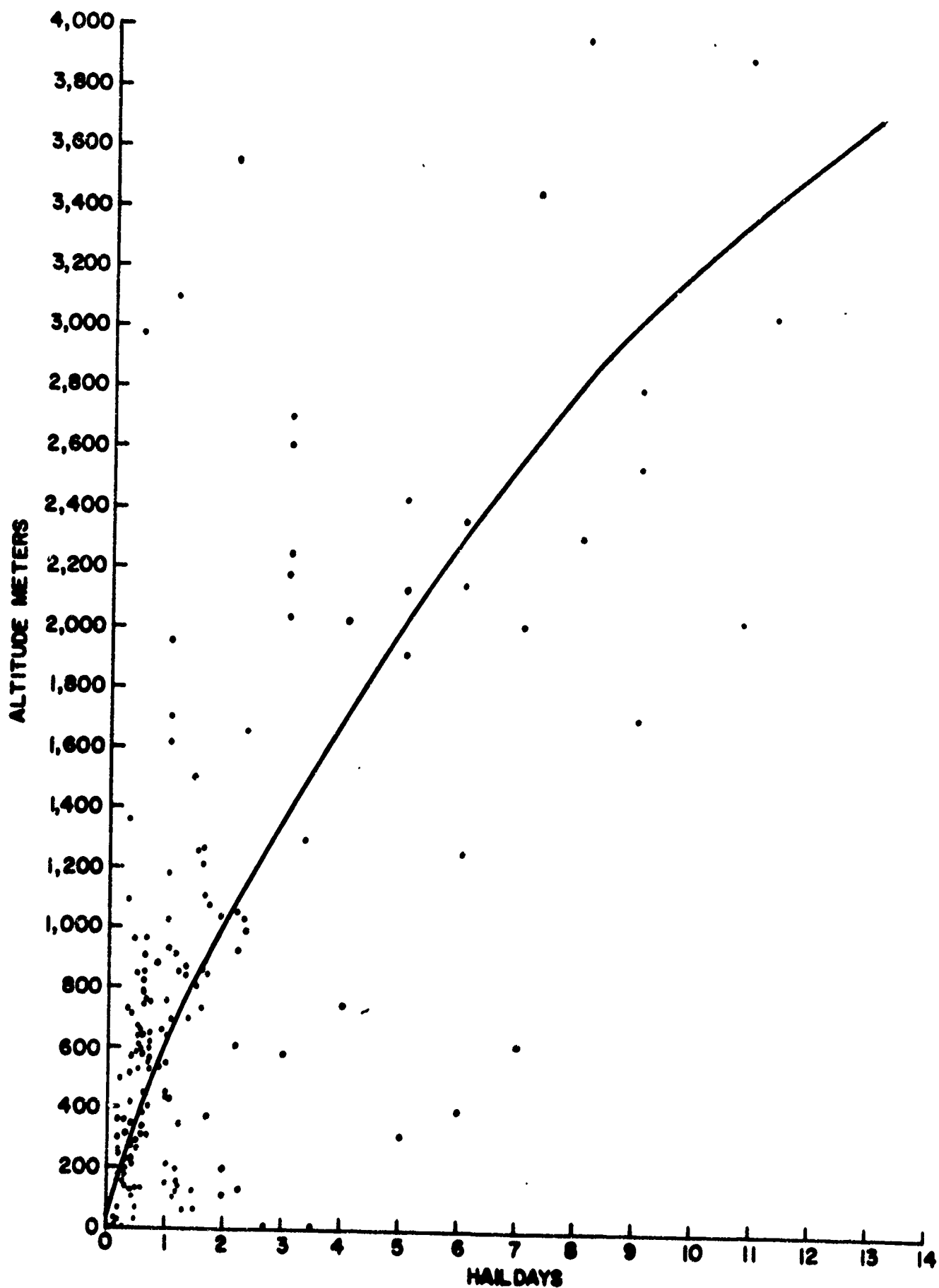
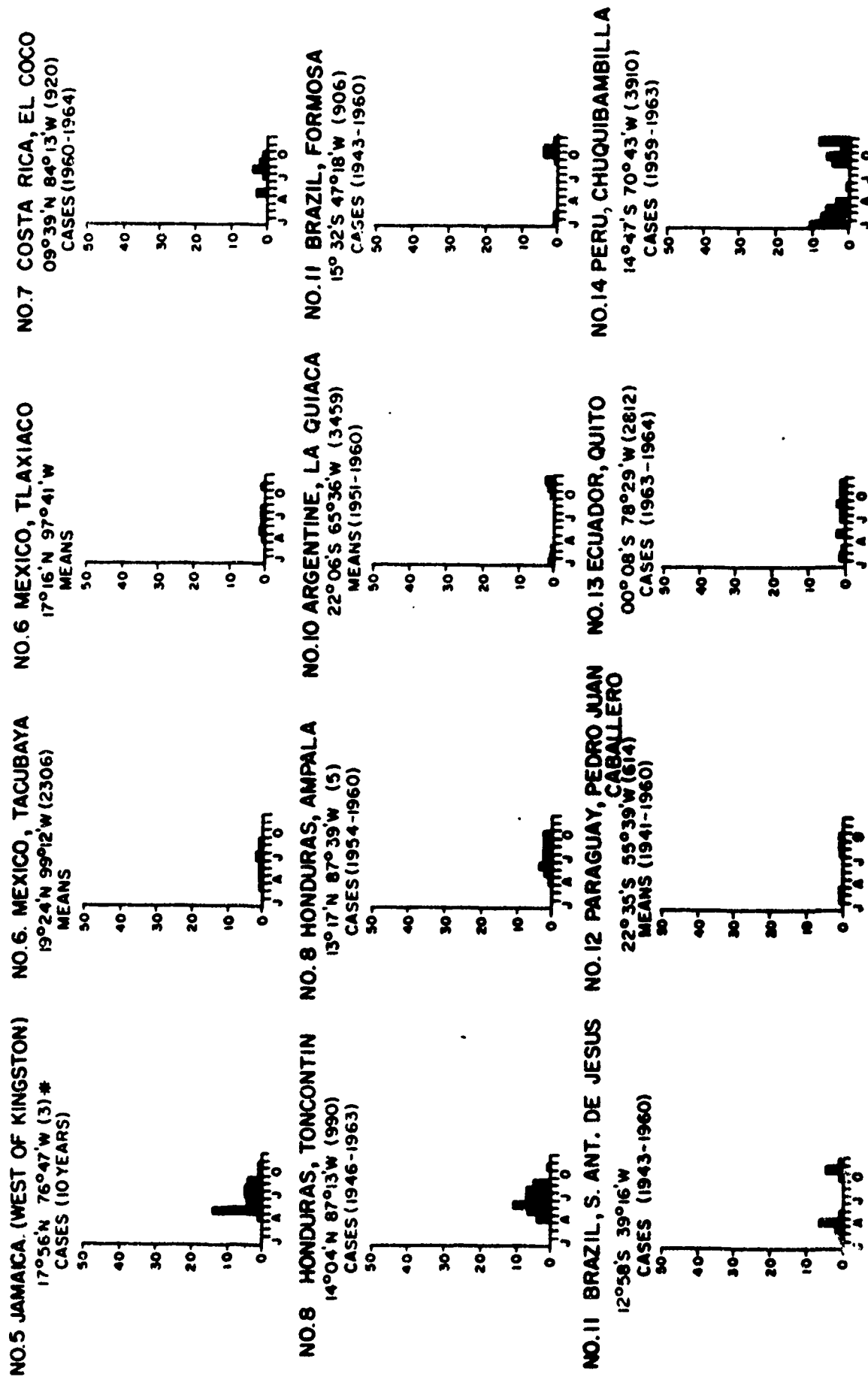


FIG. 1 AVERAGE ANNUAL NUMBER OF HAILDAYS

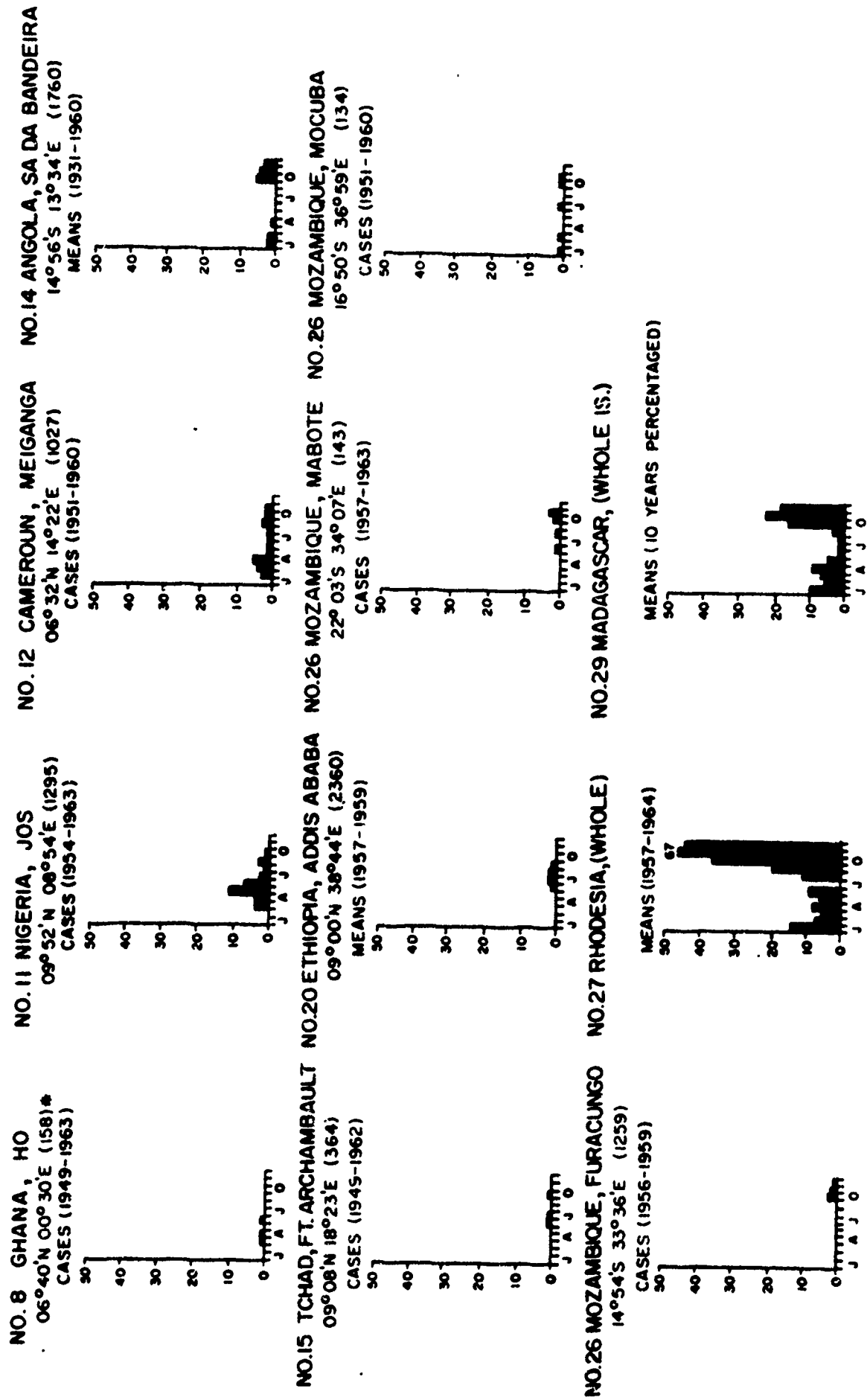
# AREA NO.1 (FIG.1)



# = STATION ELEVATION IN METERS

FIGURE 2.

## AREA NO. II (FIG. 1)



\* = STATION ELEVATION IN METERS

FIGURE 3.

# AREA III (FIG.1)

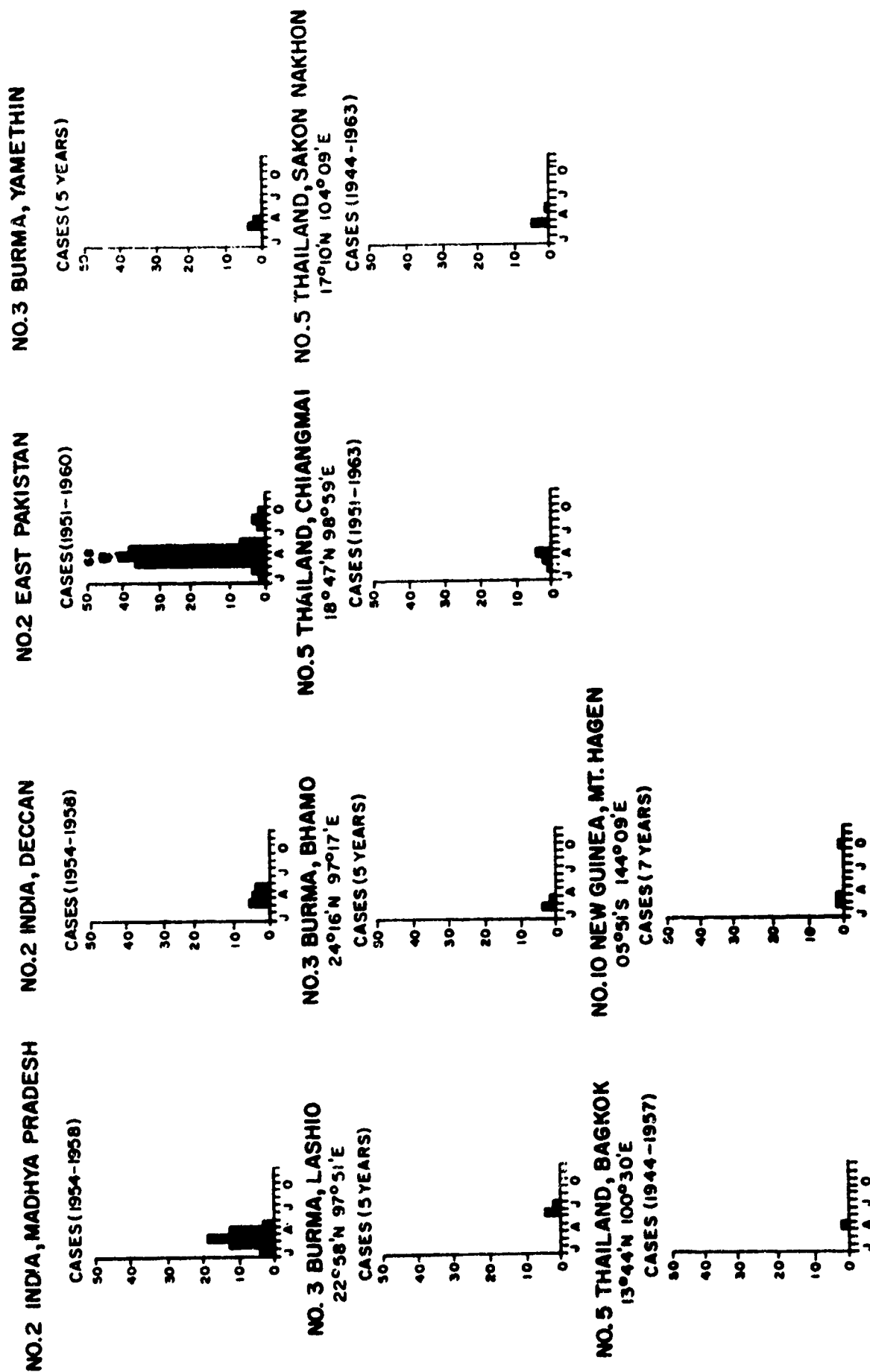


FIGURE 4.



A study of these composites made it possible to recognize three main hail regimes within the tropical band (Fig. 5). The areas within which the respective hail regimes operate are henceforth referred to as "zones" in order to differentiate them from the four "areas" of the earlier report.

Zone 1: Latitudes  $10^{\circ}$  to  $23\frac{1}{2}^{\circ}$  north of the equator, including areas of the Caribbean, Mexico, Central America, Africa, India, Asia, Hawaii, and the Philippines.

Zone 2: Latitudes  $10^{\circ}$  north to  $10^{\circ}$  south of the equator, comprising equatorial sections of South America, Africa, and Indonesia.

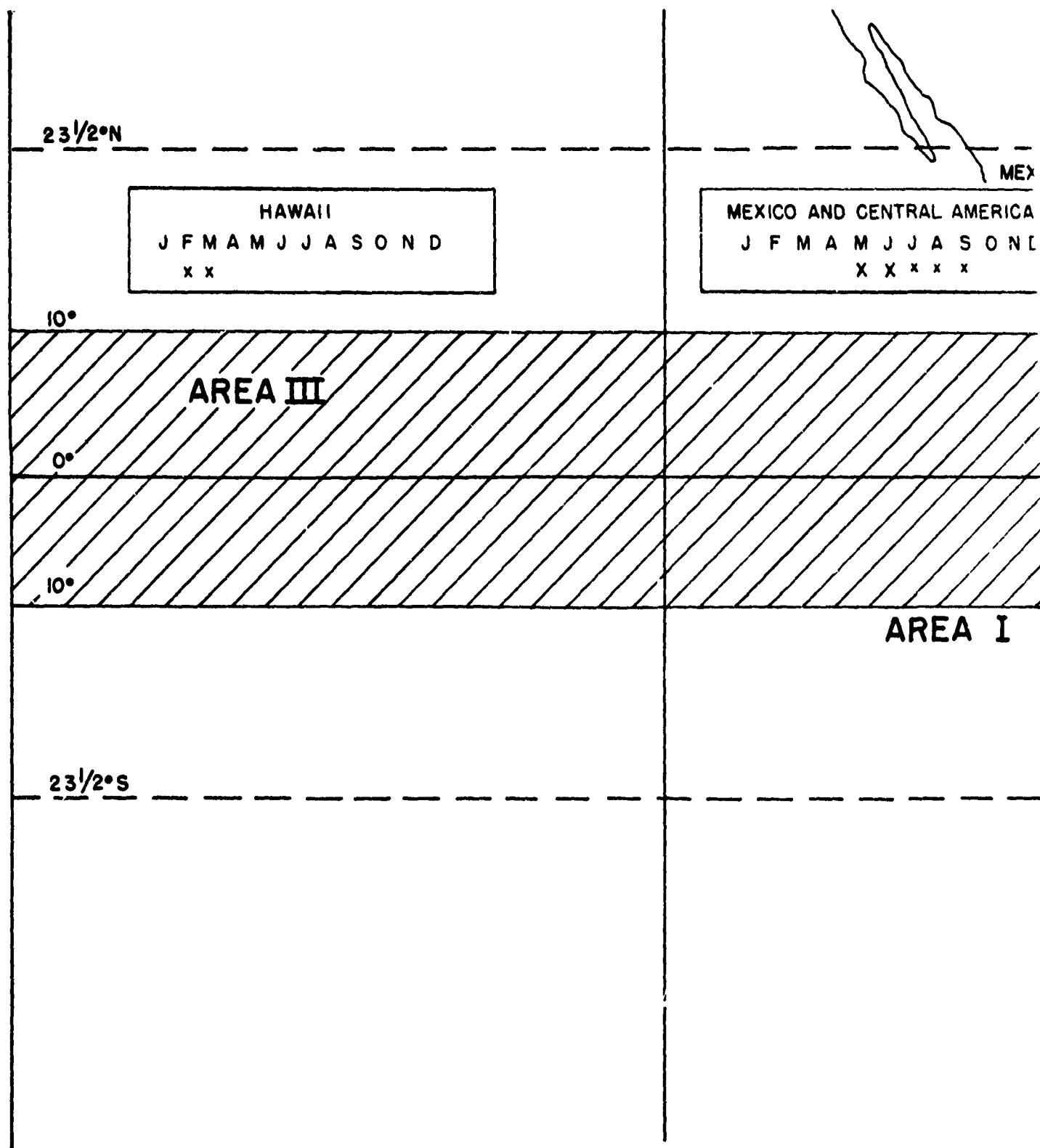
Zone 3: Latitudes  $10^{\circ}$  to  $23\frac{1}{2}^{\circ}$  south of the equator, including sections of South America, Africa, Madagascar, Northern Australia, and Polynesia (Fig. 4).

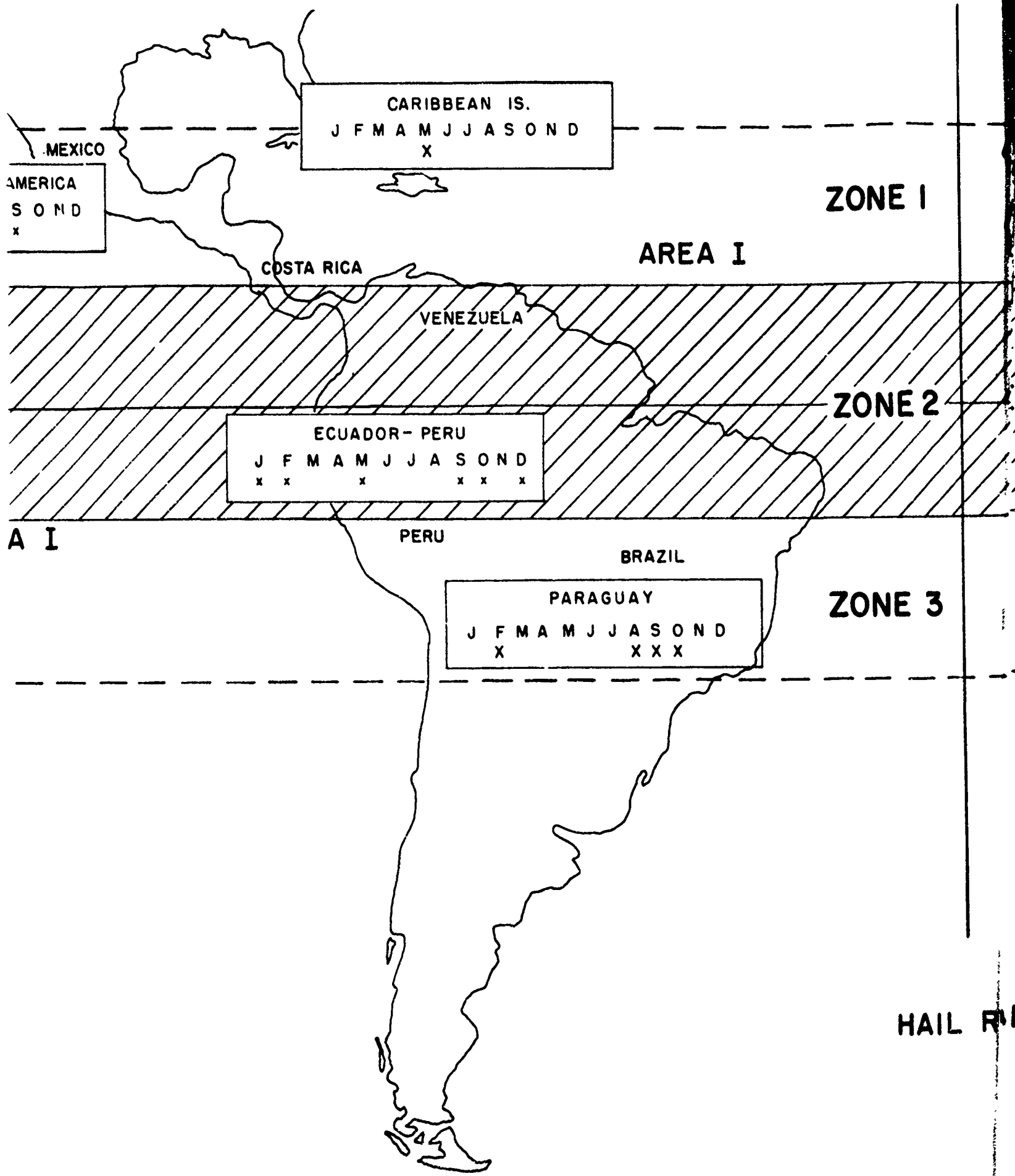
In Zones 1 and 3, hail is a feature principally of the spring months and in most instances of the relatively dry season preceding summer rains. In the Northern Hemisphere (Zone 1), the months involved are usually February to May. In the Southern Hemisphere (Zone 3), they are September to December. In Zone 2, however, the equatorial zone between Zones 1 and 3, hail appears to have at least two seasons and in some cases to occur intermittently throughout the year, e.g., Ecuador and Peru, Nigeria Cameroun, and Western Kenya. These are general statements, subject to considerable modification from place to place and year to year. Moreover, the boundaries between the zones must be regarded as transitional areas rather than narrow lines.

## CONCLUSIONS

Conclusions that may be drawn from two corollaries to the first report on "Hail incidence in the tropics" are as follows:

1. Hailstorm incidence increases with altitude in tropical as in temperate latitudes.
2. Tropical and equatorial hail regimes correspond latitudinally though not necessarily seasonally, with the rainfall regimes of the same areas; e.g., in the tropics per se, the hail season precedes the season of most rain.





HAIL R/I

# AREA II

WEST AFRICA  
J F M A M J J A S O N D  
x x x

TCHAD

SUDAN

SAUDI ARABIA

ETHIOPIA

WEST KENYA  
J F M A M J J A S O N D  
x x x x

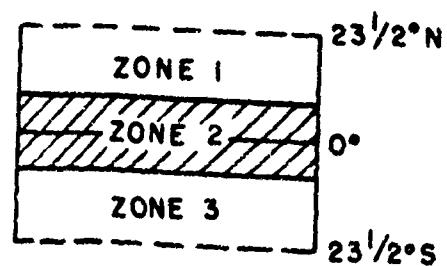
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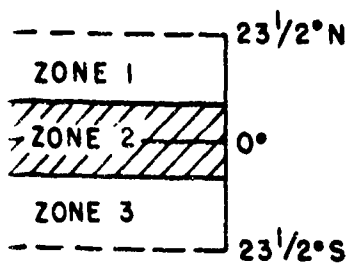
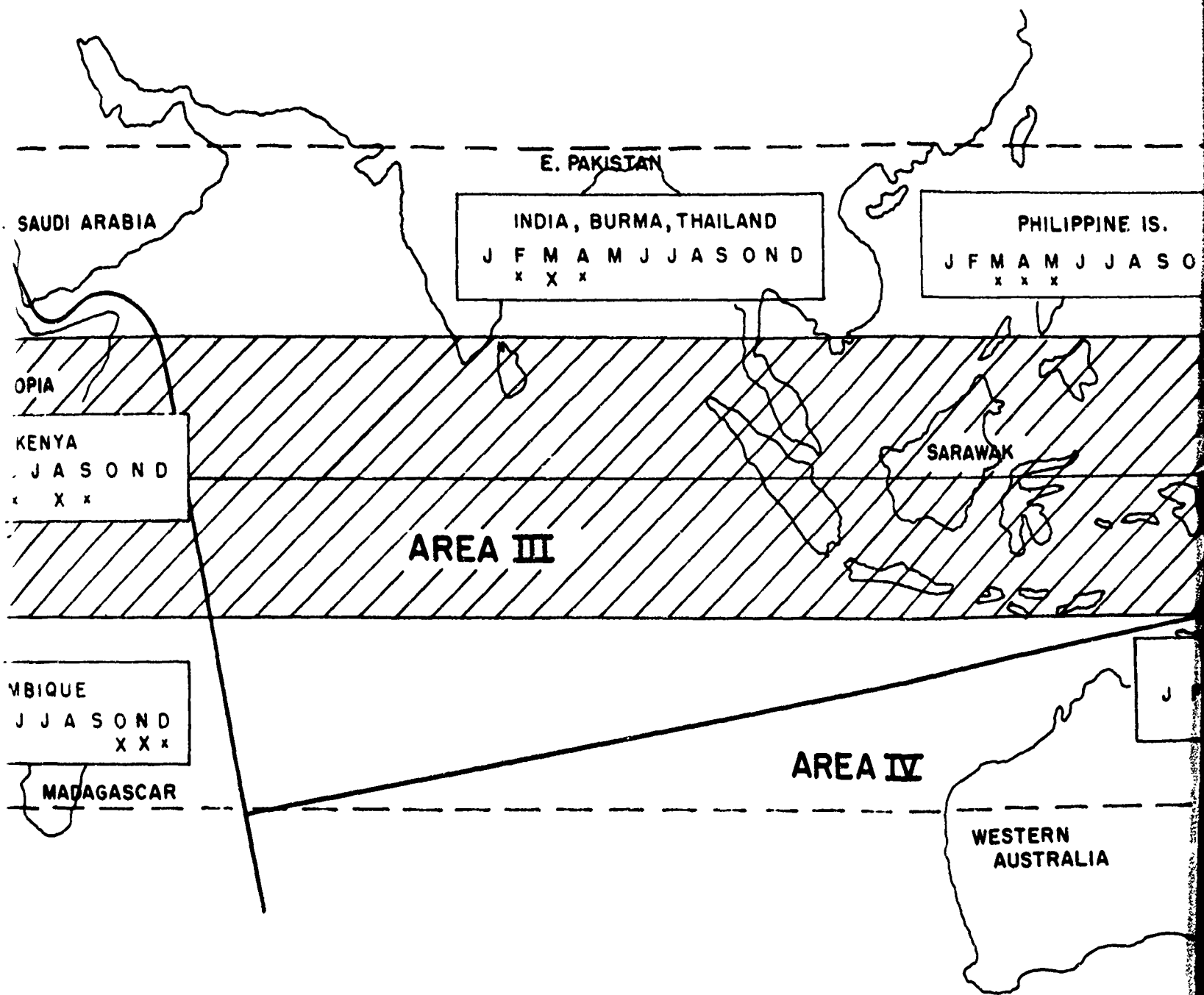
ANGOLA - RHODESIA  
J F M A M J J A S O N D  
x x

MOZAMBIQUE  
J F M A M J J A S O N D  
x x x

MADAGASCAR

L REGIMES





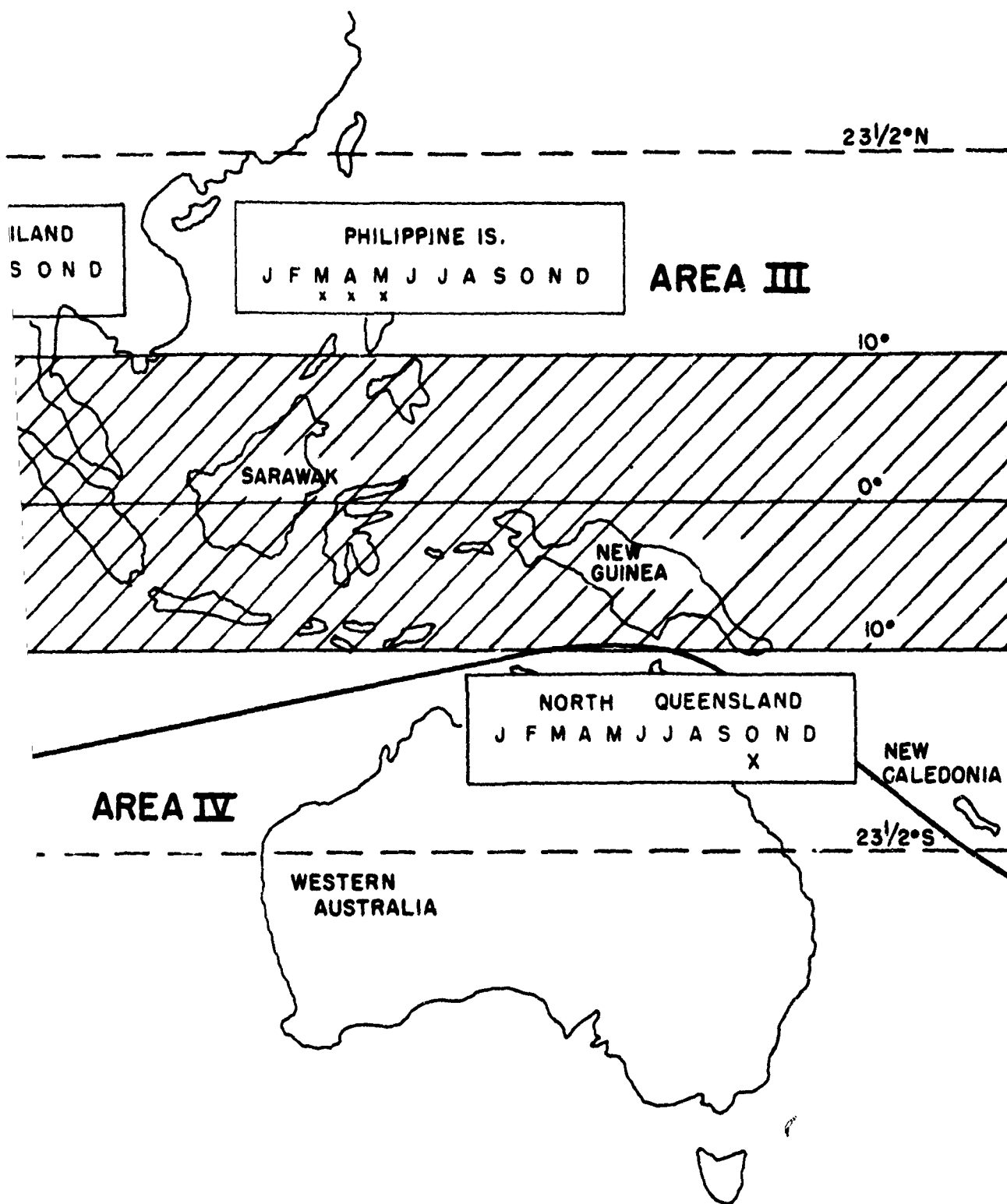


FIGURE 5.

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